I N S E C T S I N R E L A T I O N
T O
N A T I O N A L D E F E N S E

****

Circular 6

***

POWDER-POST BEETLES

***

February 1941

INSECTS IN RELATION

TO

NATIONAL DEFENSE

Circular 6 - Powder-Post Beetles

****

Table of Contents

INTRODUCTION

Buildings and stored wooden products used in connection with the National Defense Program are subject to the attack of powder-post beetles. The most important of these are the Lyctus beetles (fig. 1).

Figure 1 - Winged adult beetle of Lyctus planicollis, Lec., the southern Lyctus. Enlarged.

Lyctus beetles attack only the sapwood portion of open-pored hardwoods such as ash, oak, walnut, pecan and hickory. Many other kinds of wood, however, are susceptible to infestation. The extent of infestation and subsequent damage is in proportion to the starch content of the wood, as this substance is attractive to them (fig. 6b). Heartwood is practically free of starch and is immune to infestation (fig. 6a). Under certain conditions, damage to the finest quality stock representing a loss of 10 to 50 percent of the product is not unusual. (figs. 3 and 7).

Other beetles attack seasoned softwoods and differ from the above species in that they infest both sapwood and heartwood. Inasmuch as they attack mainly the woodwork of buildings, such as the sills, joists, subflooring, rafters, etc., the extent of damage caused by them is generally much less than that of the Lyctus beetles which attack large stores of finished products. Because of the relative unimportance of the species which infest softwoods, the following discussion is applicable particularly to the Lyctus beetles, with the exception of that portion of the control measures which relates to chemical treatment.

TYPES OF PRODUCTS LIKELY TO BE INFESTED

All classes of crude and finished hardwood products stored at Quartermaster depots by the Army and Navy are subject to attack by Lyctus beetles. Gun stock

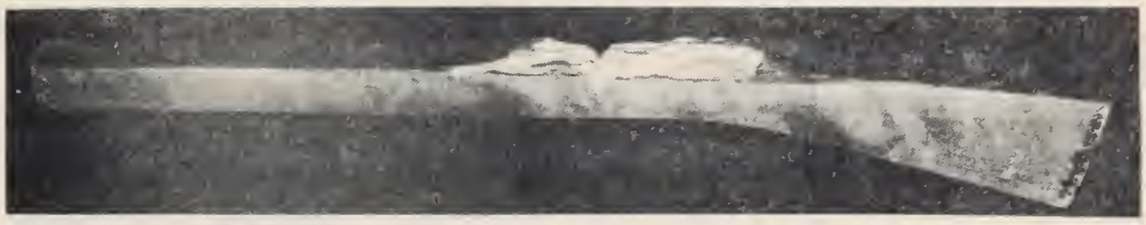

Figure 2 - Walnut gun stock blank pulverized by Lyctus planicollis (greatly reduced).

blanks (fig. 2), implement handles (fig. 6b), and wooden wheels in particular have to be watched closely. In addition the bins, floors and structural timbers made of hardwoods are subject to infestation. At administrative quarters and in officers' dwellings, such articles as furniture, filing cabinets, and floors may be damaged by these insects (fig. 3).

Figure 3 - Surface of wood removed to reveal tightly packed powder or frass made by the larvae or grubs; also a few emergence holes through surface made by the adult beetles of Lyctus planicollis (about natural size).

SYMPTOMS OF INFESTATION

During the first year of infestation the powder comes from exceedingly minute holes in the stored sapwood material of hickory, ash, oak and other seasoned hardwood products, but after the second year the small holes from which the beetles have emerged are more or less conspicuous (fig. 3). From these, flour-like powder falls and forms in piles and is readily seen when the infested material is moved or jarred (fig. 7). When the wood is cut or split the interior is often found to have been converted into a mass of closely packed powdery material which has been held together by an outer thin shell and intervening fibers of sound wood (fig. 3). The grubs, burrowing through the solid wood in all directions, have pulverized the wood fiber and have packed their burrows with this powdered wood (fig. 4). The injury done by larvae of Lyctus beetles is always confined to the white wood or sapwood, although rarely the heartwood is penetrated when the matured beetles are emerging from the wood.

Figure 4 - Larva, "grub" or "worm" of Lyctus planicollis. Enlarged.

DESCRIPTION OF THE LYCTUS BEETLES AND THEIR HABITS

The winged adult Lyctus beetles are small, slender, somewhat flattened, reddish brown to nearly black, and about three-sixteenths inch in length (fig. 1). They lay their eggs (fig. 5) in the pores of the wood, and the

Figure 5 - Eggs of Lyctus planicollis inserted in pore in wood. Enlarged about 50x.

larvae or grubs (fig. 4) which hatch from them burrow through the wood and reduce the fiber to a flour-like powder (figs. 2, 3 and 7). The different kinds of Lyctus beetles vary somewhat in their habits and seasonal history, but there is a general similarity. Under outdoor conditions they pass the winter as larvae in the wood, change to pupae (the resting stage) in early spring, and in late spring and early summer the adult beetles emerge from the wood and fly about. In storehouses, or other buildings that are kept warm and dry the development is hastened and the adult beetles may emerge during the latter part of the winter or early in the spring. In the extreme south, one species may have more than a single generation a year.

MEASURES FOR PREVENTING LYCTUS INFESTATION

Careful Selection and Grading of Stock

Of prime importance in protecting stores of rough hardwood products in the process of seasoning and of the more valuable manufactured articles from Lyctus injury, is the selection of stock which is naturally immune or at least somewhat resistant to attack. The likelihood of infestation is mainly in direct proportion to the quantity of sapwood present in the product and the amount of starch it contains.

Inasmuch as heartwood is immune to infestation (fig. 6a) it is desirable to obtain all heartwood material where possible. Heartwood has not been readily accepted by the trade at large because of the deep color. It is just as serviceable, however, as the sapwood (fig. 6b) and is free from losses due to Lyctus attack. The Forest Products Laboratory of the Forest Service has conducted exhaustive strength tests and has found that the heaviest and consequently the strongest hickory averages more than 10 growth rings per inch; also that weight for weight, red hickory (heartwood) is as strong as white hickory (sapwood).

It is recognized that in many cases it will be impossible to obtain all heartwood, and therefore, in order to simplify the periodic inspections which should be made, the stock should be graded and stored by type of material, such as (1) heartwood, (2) pure sapwood and (3) part sapwood.

Figure 6 - Two finished hickory spokes

a. Red heartwood, undamaged

b. White sapwood, severely damaged by Lyctus planicollis

(greatly reduced)

The material should also be piled according to age, since the longer the stock is exposed to infestation, the greater is the probability of damage. If the above system is followed, the heartwood pile never need be disturbed. If not so classified, all of the stored product has to be handled each time an inspection is made.

Frequent Inspections

Another means of keeping losses at a minimum, is to make frequent inspections, especially during the spring and early summer. The discovery of small piles of powder-like dust coming from tiny holes (fig. 7) indicates that infestation has taken place and that action should be

taken immediately to separate the stock containing live "worms" from the uninfested stock. This will prevent spread of the infestation. In the case of heated buildings, it is important to make at least one mid-winter

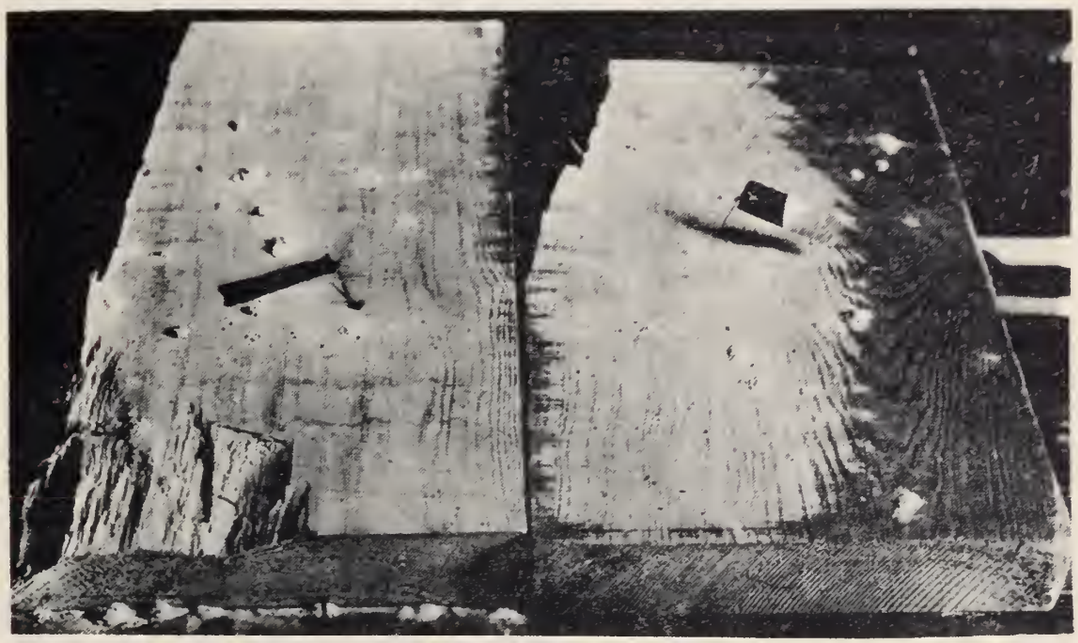

Figure 7 - Ash sapwood (airplane stock) destroyed by larvae of Lyctus planicollis. Note telltale piles of powder pushed to surface of wood; also holes in surface (greatly reduced).

inspection, because under such conditions the small black beetles (fig. 1) begin to emerge any time after the middle of February. Once emergence has taken place, all of the sapwood stock which has not been chemically treated is liable to attack.

Inasmuch as it is difficult at times to detect early stages of infestation and often impractical to make periodic inspections, it may be desirable to insure protection and avoid inspections by treating chemically all of the sapwood stock.

Chemical Treatments to Act as Repellents

As the result of recent research, a number of chemical treatments have been developed for use in protecting rough and green as well as seasoned finished products against Lyctus attack. These are surface treatments and in the case of rough products that are later to be converted into finished articles, retreatment is advisable following such conversion. These materials have been tested on a commercial scale and found to be practical for use where the necessary facilities for handling are available. A simple way to treat lumber and other bulky products is to provide a vat or other suitable container in which to immerse the wood for a given period.

When preparing large quantities of the chemical it is often convenient to run a one-half inch steam line jet into the container in order to heat the solution and agitate it sufficiently to hasten getting the chemical into the solution. In addition a steam coil of sufficient size should be laid at the bottom of the container to hold the temperature of the solution at about 180°F. This procedure is particularly desirable in the use of borax and sulphur, since these chemicals are suitable for treating green lumber and other rough products.

(1) Borax: When borax is to be used, a 5 percent concentration is readily mixed by dissolving 22 pounds of borax in 50 gallons of water. When the temperature of the solution is held at 180°F. the green wood should be immersed for a period of 10 seconds. Borax is cheap, readily available and free from health hazards.

(2) Sulphur: Another promising dip recently discovered is sulphur. Lyctus beetles avoid sulphur treated wood when non-treated material is available. If they do crawl over treated wood, the sulphur causes the females' ovipositors to become distended and paralyzed, thereby preventing egg laying and larval attack.

A 1 to 2 percent concentration is prepared by mixing 4 to 8 pounds of "sulfocide" or other finely divided

sulphur, such as microfine sulphur or dry lime sulphur, with 50 gallons of water. A satisfactory treatment for green wood consists of a 10 second immersion in the mixture at a temperature of 190°F. This treatment is less costly (5 to 8 cents per thousand board feet) than that of borax (18½ cents per thousand board feet) and has the advantage of giving somewhat greater protection against Lyctus attack. Sulphur has not been as thoroughly tested on a commercial scale as has borax as its discovery for such use is so recent. Present results, however, are most encouraging.

(3) Pentachlorophenol: This is one of the most effective chemicals for use in preventing Lyctus beetles from attacking seasoned wood. The most desirable carrier appears to be a light fuel oil of the kerosene type. At ordinary temperatures of around 68°F., about 3 percent of crystalline pentachlorophenol by weight will dissolve in the oil. Heat increases its solubility and agitation hastens the process. When difficulty is experienced in obtaining quick solubility, the addition of 5 percent of a more active solvent, such as pine oil will be found quite helpful. These solutions may be obtained already prepared under trade names. It has been determined that seasoned lumber and other products immersed for a period of 10 seconds in a 3 percent solution of pentachlorophenol was effectively protected against Lyctus attack. Oil treatments are limited to seasoned wood.

(4) Linseed Oil: For treating more expensive seasoned finished products, it may be advantageous to use boiled linseed oil which is readily available locally. Boiled linseed oil should be applied hot to be most effective; two applications should be made if a brush is used. Where a large quantity of stock is involved, it may be more practical to immerse the material in a tank containing the oil. A little kerosene added to the hot oil, aids rapid penetration. Linseed oil stains the wood slightly yellow.

Period of Protection

As indicated above, the chemical treatments recommended, with the exception of linseed oil, are the result

of recent experimental work and consequently the period of protection offered beyond 1 or 2 years is unknown.

MEASURES FOR CONTROLLING LYCTUS AND OTHER POWDER-POST BEETLE INFESTATIONS

Sanitation

Once infestations have been discovered and the attacked material has been separated from the remainder of the stock, it should be destroyed by burning if sufficiently damaged. If it is only lightly attacked and still serviceable, the infested portion should be trimmed off and burned or treated with a penetrating chemical. In addition all refuse stock which might be harboring beetles should be removed and destroyed.

Chemical Treatments

Infested serviceable material can be treated chemically either by surface applications or by immersing the product in a vat for a certain period. The method used depends upon the quantity of material involved and the facilities available for treatment.

Precautions Necessary in Handling Chemicals

Reasonable care should be taken in connection with handling the chemicals that are suggested for use in treating infested wood. Some of these chemicals, as orthodichlorobenzene, pentachlorophenol and creosote, will cause irritation of the skin of certain people. It is therefore advisable to wear chemically resistant (rubberized fabric or neoprene treated) gloves and aprons. The eyes should be protected by goggles, especially if the chemical is to be applied to overhead timbers. Rooms where treatment is being applied should be well ventilated so as to avoid headache or nausea. When possible, equip the room where considerable treating is to be done, with a fan or blower adequate to remove fumes. Also follow the directions furnished by the companies marketing the chemicals for safe use and antidotes. These mixtures should not be heated over a direct fire. Where possible dip the wood in vats of these mixtures which are heated by coils of steam pipes.

Surface Applications

High grade seasoned products, especially finished manufactured articles like furniture or floors of buildings are best treated by surface applications with suitable penetrating toxic substances.

(1) Orthodichlorobenzene: This is one of the most penetrating and effective liquids for killing all stages of powder-post beetles in infested wood. The wood should be liberally saturated with it or dilutions of it with cottonseed or light petroleum oil up to 50 percent. Where the borers are deeply imbedded, more than one application may be necessary to reach all of the active forms. Treated material should be kept under observation in a warm room for several days to determine the full effectiveness of the chemical. It is quite likely that the finish on the surface of the wood will be marred; however, the surface can be refinished subsequently.

(2) Turpentine and Kerosene Mixture: Where there is danger of marring the finish on the wood, a mixture composed of 9 parts turpentine to 1 part kerosene may be used, although this mixture is not as effective as is orthodichlorobenzene.

Immersion

There are several chemicals and mixtures which are suitable for treating wooden products in vats. Where facilities are available, such applications are more likely to insure successful treatments than is possible by surface applications.

(1) Pentachlorophenol: Another material which is about as penetrating as orthodichlorobenzene is pentachlorophenol. It is very effective in killing Lyctus in all stages present in seasoned stock up to 4 inches thick when submerged in a 5 percent solution in a light fuel oil for a period of at least 5 minutes. Larger stock will require longer periods of immersion.

(2) Light Pine Oils: These oils have been used effectively in treating infested wood and also do not mar the finish.

(3) Kerosene: Another readily available material is kerosene. It has a fire hazard and slightly raises the grain and it is difficult to stain kerosene-treated sapwood so as to match the rest when articles need to be finished or refinished.

Heat Treatments

In some instances as at aircraft factories and shipyards, facilities may be available for killing Lyctus beetles in various stages of development in infested stock by means of heat treatments. For this purpose a kiln or other suitable chamber in which temperatures and humidities can be regulated is necessary. Such treatments are practical when large stores of infested lumber or other wood products are concerned.

Dry Heat

Where dry heat is used, a kiln treatment which will raise the temperature throughout the wood to at least 120°F. will be effective in killing powder-post beetles.

Moist Heat

Another method of effectively treating infested stock is to place it in a kiln which is supplied with live steam and then gradually raise the temperature to the degree necessary to produce mortality. After all parts of the product have reached the designated kiln temperature, such temperature is maintained for the required period to kill all stages of the beetles. Inasmuch as wood is a poor conductor of heat, its temperature rises slowly. The time required for wood to acquire the kiln temperature is called the "lag" period. This varies according to the thickness of the wood.

In Table No. 1 it will be noted that an additional short safety period is allowed even after the designated lethal period has expired to make certain of an effective treatment. Thus, to successfully treat infested stock such as ash sapwood one inch thick when exposed to a kiln temperature of 130°F. under conditions of a saturated atmosphere, it requires 1/2 hour for the "lag" time, 1-1/2 hours for the treatment at the constant temperature and 1/2 hour additional safety period, or a total of 2-1/2 hours. Lower temperatures and humidities in the kiln lengthen the period of exposure for material of the same thickness. Heavier dimension stock also greatly increases the period required for successful treatment.

Table 1. - Schedule for treating wood to check damage by powder-post beetles.

Relative humidity (percent)	Lethal temperature required	Thickness of timber	Time required to overcome lag after kiln has attained lethal temperature	Additional margin of safety	Time then held at lethal temperature	Total period of exposure after kiln has attained required conditions
	°F.	Inches	Hours	Hours	Hours	Hours
100	130	1	½	½	1½	2½
		2	2	½	1½	4
		2½	3¼	½	1½	5¼
		3	4½	½	1½	6½
	125	1	½	½	2	3
		2	2	½	2	4½
		2½	3¼	½	2	5¾
		3	4½	½	2	7
80	120	1	½	1½	6	8
		2	2	1½	6	9½
		2½	3¼	1½	6	10¾
		3	4½	1½	6	12
	115	1	½	7½	30	38
		2	2	7½	30	39½
		2½	3¼	7½	30	40¾
		3	4½	7½	30	42½
60	125	1	½	1	4	5½
		2	2	1	4	7
		2½	3¼	1	4	8¼
		3	4½	1	4	9½
	120	1	½	2	7	9½
		2	2	2	7	11
		2½	3¼	2	7	12¼
		3	4½	2	7	13½
	115	1	½	9	36	45½
		2	2	9	36	47
		2½	3¼	9	36	48¼
		3	4½	9	36	49½

LIST OF COMPANIES HANDLING CHEMICALS AND THE TRADE NAMES OF THE LATTER

Borax:

E. I. duPont deNemours & Co., Inc., Wilmington, Del.
Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.
Mallinckrodt Chemical Works, 3600 No. Second St., St. Louis, Missouri
Pacific Coast Borax Co., 51 Madison Ave., New York City

Coal-tar Creosote Oil: (Grade 1, Federal or American Wood Preservers' Specifications)

Barrett Company, 40 Rector St., New York City
Bermuth Lembcke Co., 420 Lexington Ave., New York City
Creosote Sales Corp., Lexington Bldg., Baltimore, Md.
James Good, Inc., Susquehanna Ave. and Martha St., Philadelphia, Pa.
Koppers Company, Tar and Chemical Division, Pittsburgh, Pa.
Los Angeles Chemical Co., 1960 Santa Fe Ave., Los Angeles, Calif.
Monsanto Chemical Works, 1700 So. Second St., St. Louis, Missouri

Orthodichlorobenzene: (Orthene or O. D. B.)

Capitol Chemical Co., 1050 30th St., N.W., Washington, D. C.
Dow Chemical Co., Midland, Michigan
E. I. duPont deNemours & Co., Inc., Wilmington, Del.
James Good, Inc., Susquehanna Ave. and Martha St., Philadelphia, Pa.
Hooker Electrochemical Co., 60 East 42nd St., New York City
Hughes Chemical Co., 1424 Philpot St., Baltimore, Md.
Mallinckrodt Chemical Works, 3600 No. Second St., St. Louis, Missouri
Monsanto Chemical Works, 1700 So. Second St., St. Louis, Missouri
Solvay Sales Corp., 40 Rector St., New York City

Pentachlorophenol: (Dowicide G, Permasan or Permatol A, Permaseal, Permatox and Wood-tox.)

Dow Chemical Company, Midland, Michigan
Monsanto Chemical Works, 1700 So. Second St., St. Louis, Missouri

Microfine Sulphur:

Acme White Lead & Color Works, Detroit, Michigan
American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York City
Freeport Sulphur Co., 122 East 42nd St., New York City

Sulfocide:

B. G. Pratt, 50 Church St., New York City
California Spray Chemical Corp., Richmond, Calif.
E. I. duPont deNemours & Co., Inc., Wilmington, Del.
Freeport Sulphur Co., 122 East 42nd St., New York City

Neoprene Treated Gloves:

American Anode, Inc., 60 Cherry St., Akron, Ohio

The above list of concerns and their products is included for the information of the users of this circular, without given or inferred guarantee of the reliability of the firms or endorsement of their individual products. No attempt has been made to make the list fully complete and no discrimination is intended or implied against firms whose names or products are not listed.

LIST OF PUBLICATIONS ON POWDER-POST BEETLES AND THEIR CONTROL

Christian, M. B. -- 1939 -- Chemical dip tests against Lyctus powder-post beetles. Southern Lumberman 159 (2009): 105-109, Dec. 15.

-- 1940 -- Lyctus powder-post beetles and their control. "Pests" 8(6): 8-9 and 10, figs. 4, June, Kansas City, Mo.

-- 1940 -- Lyctus beetle damage prevention. Southern Lumberman 160 (2021): 47-9, 3 figs., June 15.

St. George, R. A.-- 1929 -- Protection of log cabins, rustic work, and unseasoned wood from injurious insects. Farmers' Bull. 1582, p. 19, figs. 23.

Snyder, T. E. ----- 1916 -- Egg and manner of oviposition of Lyctus planicollis. Jour. of Agr. Research, Vol. VI, No. 7, Dept. of Agr., Washington, D. C., May 15.

-- 1923 -- High temperatures as a remedy for Lyctus powder-post beetles. Jour. For. v. 21, No. 8, pp. 810-814.

Snyder, T. E. and St. George, R. A.-- 1924 -- Determination of temperatures fatal to the powder-post beetle, Lyctus planicollis LeConte, by steaming infested ash and oak lumber in a kiln. Jour. Agr. Research, v. 28, no. 10, pp. 1033-38, illus.

Snyder, T. E. ----- 1926 -- Preventing damage by Lyctus powder-post beetles. U.S.D.A. Farmers' Bull. No. 1477. March (revised Sept. 1936, Feb. 1938)

-- 1927 -- Defects in timber caused by insects. Dept. Bull. 1490, U.S.D.A., pp. 46, figs. 45, July.

-- 1935 -- An introduced Anobiid beetle destructive to houses in the Southern States. Proc. Biol. Soc. Wash., Vol. 48, pp. 59-60, Pl. III, May 3.

-- 1938 -- The present status of the Lyctus problem. Yearbook National Hardwood Lbr. Ass'n., pp. 84-90, fig. 1, October, Chicago, Ill.